THE EFFECTS OF DEPARTMENT OF DEFENSE ORGANIZATION ON ATTACK AIRCRAFT CARRIER BUDGETING

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THESIS

The Effects of Department of Defense
Organization on Attack
Aircraft Carrier Budgeting

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ABSTRACT

This analysis establishes and tests conditions for consistency of the post-appropriation resource allocation to attack aircraft carriers by the Navy and plans made by the Office of the Secretary of Defense under the Planning Programming Budgeting System. The Cobb-Douglas and Leontief production functions, using carrier operating tonnage as an output measure and Military Personnel and Operations and Maintenance appropriation dollars as inputs, are considered as possible models to explain the implicit economic technology used during different phases of the budgeting process. Econometric techniques, correlation analysis and other methods are used in analyzing data covering 1964 through 1973. A conclusion is reached that the Navy post-appropriation resource allocation did in fact alter plans made by OSD; both Department of Defense organization and other factors are discussed as potential explanations for the observed results.

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I. INTRODUCTION

The purpose of this paper is to report the results of research directed toward investigating the effects of Department of Defense (DOD) organization on budgeting on one program element in the defense budget: Attack Aircraft Carriers.

The problem was defined as one of determining if the Navy's resource allocation to carriers after Congressional budget action, hereafter referred to as the service budget, was consistent with the resource allocation arrived at during the Planning Programming and Budgeting System (PPBS) cycle, hereafter referred to as the program budget, from which the Congressional submission was prepared. Additionally, the problem was restricted to the comparison of resource allocations for only the operation of carriers and not for procurement.

The formal analysis is preceded by a background discussion in Section II. of the theoretical aspects of program budgeting, a brief descriptive summary of the PPBS cycle as practiced by DOD, and a discussion of two organizational models used by Ruefli [17] in a paper which provided the motivation for this investigation. Section III. is a description of the methodology and the data used in the analysis itself, Section IV. The analysis is conducted by modeling and comparing the results of the budgetary actions

of the Office of the Secretary of Defense (OSD) and of the Navy as microeconomic production functions. Section V. consists of a summary of the results of the analysis, conclusions concerning apparent differences in the budgeting actions of the Navy and OSD, and a discussion of possible explanations for these apparent differences. Additionally, Section V. discusses several topics for further study and research concerning the defense budget.

II. BACKGROUND

A. THE THEORY OF PROGRAM BUDGETING.

The purpose of this section is to discuss the basic theory of program budgeting. It is the theory to be discussed in this section which led the author to conclude that resource allocations in the defense budget process, with regard to attack carriers, might be susceptible to modeling via a production function and that differences between decisions at the OSD and service level might be analyzed by estimating a production function for each level.

The term "program budgeting" has many definitions. As McKean and Anshen [16, p. 286] point out, to some people it means a multiyear budget, to others it means the use of cost utility analysis, and to others it means both of these together with a, "re-structuring of budgeting exhibits, accumulating costs in more meaningful categories." As Wildavsky [23, p. 302] points out,

> Program budgeting has no standard definition. The general idea is that budgeting decisions should be made by focusing an output categories like government goals, objectives, end products or programs instead of inputs like personnel, equipment and maintenance.

The basic concepts are best conveyed by examining the structure of the accounts, called the program structure.[1] A

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[1]The following discussion is based on Ref. 18.

program structure for an organization such as the Department of Defense (DOD) which produces multiple outputs can be formed by grouping activities producing substitutive outputs together under one program. These activities are called program elements. For example B-52's, Titan ICBM's and Polaris submarines all produce substitutive outputs and can be grouped under the program Strategic Offense.[2] Hitch [8, p. 32] described the building of a program structure in the following way,

> The problem was to sort out all the myriad programs and activities of the defense establishment and re-group them into meaningful program elements, i.e. integrated combinations of men, equipment and installations whose effectiveness can be related to our national security objectives.

A typical program structure might look something like the following:

- Program 1
  - Program Element (PE) 1-1
  - Program Element (PE) 1-2
- Program 2
  - PE 2-1
  - PE 2-2
  - PE 2-3
- Program 3
  - PE 3-1
  - PE 3-2

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[2] Other important considerations in putting together a program are discussed by Smithies [18, p. 24-60].

The program structure for the organization depicted above contains three programs, that is the organization has three missions or outputs. Two substitutive program elements are grouped under Program 1, three under Program 2 and two under Program 3.

Program budgeting is not just the structure of the accounts, however, rather it involves the allocation of resources (or inputs) to the various program elements based, first of all, on their contribution to the effectiveness or output of the program element. Suppose given amounts of resources A and B are allocated to Program 1. A program budget seeks to maximize the effectiveness of the mix of PE 1-1 and 1-2 by allocating resources A and B to these program elements in such a way that the marginal product of A for PE 1-1 equals the marginal product of A for PE 1-2, and the marginal product of B for PE 1-1 equals the marginal product of B for PE 1-2. Resource allocation under programs budgeting within a program is based on a goal of optimizing the effectiveness of the program (provided the program elements within a program are producing substitutive outputs). Resource allocation between programs is more difficult since it involves comparisons of outputs which are not substitutes for each other, such as strategic offense and tactical air power. This allocation depends not only on the marginal productivities of the resources but also on the preferences of a decision maker for the various non-substitutive outputs, i.e. the utility of the outputs produced by the program elements in different programs.

In the analysis that follows in this paper, the inputs A and B which will be used are composite commodities or inputs, military personnel dollars and operations and maintenance dollars. The program element which will be examined is a program element under the General Purpose Forces program, Attack Aircraft Carriers. The specification of the inputs and the output will be discussed in Section III.A.

The preceding discussion has emphasized the resource allocation problem which program budgeting is designed to address. It should be clear that to do program budgeting and in order to optimally allocate resources, production functions of some kind for the program elements must be known or assumed by the budgeting authority. Hitch [8, p. 27, 28], in discussing program budgeting in the early sixties, emphasized this point when he said,

> Secretary McNamara made it known that he wanted to manage the defense output in terms of meaningful entities - of 'outputs' like the B-52 forces, the Polaris force, the Army Airborne Division forces, etc., associating with each all the inputs of equipment, personnel, supplies, facilities and funds regardless of the appropriation account in which each was financed. He wanted to know and indeed would have to know in order to optimize the allocation of resources, the cost of, for example, a B-52 wing - not only the cost of equipping the wing but also the cost of manning and operating the wing for its lifetime or at least for a reasonable period of years in the future. Only then would he be in a position to assess the cost and effectiveness of a B-52 wing as compared with other systems designed to perform the same or similar tasks.

Specification of a production function for attack carriers and estimation of its parameters will be an important part of this analysis and will be discussed further in Section III.

B. THE BUDGET PROCESS WITHIN THE DEPARTMENT OF DEFENSE

The major question addressed by this paper deals with consistency of OSD and Navy decisions at different stages of the budget cycle. Before addressing this question, some background discussion on the DOD budget process is necessary in order to identify the points at which consistency of decisions will be examined.

During the 1960's program budgeting became well entrenched in the budgeting process of the federal government in general and in that of the DOD in particular. As discussed earlier, the system was designed to inject a greater degree of rationality into the federal government's resource allocation process through the identification and specification of objectives and through the use of analytical techniques to facilitate tradeoffs between defense programs and program elements.

When former Secretary of Defense Robert McNamara and his Comptroller for the Department of Defense, Charles Hitch, took over the department in January 1961, they sought to introduce program budgeting into the defense resource allocation process by means of a three-phase program budget cycle. Since its inception in DOD, the program budgeting

cycle, generally known as the PPB cycle, has undergone many changes in procedure during both the McNamara and Laird-Packard eras of administration, however, the timing of the different phases and their purposes seem to have remained constant. The following description of the budget process, extracted from Refs. 2, 3 and 17, constitutes an overview of the general budget process as it was conducted during both administrations.

The planning phase was conducted during the period 18-24 months preceding the beginning of the fiscal year for which the budget was being prepared. This phase consisted primarily of threat analysis conducted by the Joint Chiefs of Staff and the Office of the Secretary of Defense (OSD), as well as initial estimates of the forces required to meet these threats.

The programming phase occurred during the approximate period 9-18 months preceding the fiscal year. This phase may be described as a dialogue between OSD and the services which was concerned primarily with the selection of programs, program elements, and force levels.

The concept of programs and program elements was discussed in the previous section and a complete listing of the ten major programs appears in Appendix A, Defense Programs and Appropriations. In order to understand the concept of force level, it is only necessary to refer to Hitch [8, p.32].

> Wherever possible, program elements are measured in physical terms such as numbers of aircraft per wing, numbers of operational missiles on launchers, number of active ships...

These numbers are what is meant by the term force levels.

The end product of the programming phase was the Five Year Defense Plan (FYDP) which contained DOD's updated list of programs, program elements, force levels, and attendant resources not only for the ensuing fiscal year but for the following four years as well. It should be noted that this phase emphasized the program nature of the defense budget through coordination across service lines and the determination and evaluation of tradeoffs among defense programs and program elements.

The budgeting phase occurred during the October through December period immediately preceding the submission of the budget to the Congress in January. Up to this point the budget was considered in a program format, but it was now crosswalked (costed out) into the traditional appropriation format for submission to the Congress.

The term crosswalk refers to the process of aggregating the resources needed by the program elements into resource categories. This aggregation is necessary first of all because the Congress examines the defense budget in terms of the resource categories Military Personnel, Operations and Maintenance, Procurement, etc., a complete listing of which appears in Appendix A. Secondly, the Department of Defense

also manages to some extent in terms of resources. For example, DOD manages the acquisition, training, and careers of military personnel. Crosswalking involves going through all program elements and summing up, for example, the military personnel or operations and maintenance dollars they require at the approved force levels. This information on each program element is stored with the Program Element Summary Data and contains the approved force levels and the resources required by that program element. Appendix B, Program Element Summary Data is an example of a hypothetical program element.

This brief description concludes the process that most of the literature on the subject considers to be the Planning, Programming and Budgeting System (PPBS). Two phases of the defense budget process subsequent to the three already mentioned have a great deal of influence on the actual operation and implementation of the overall defense program.

During the fourth phase the defense budget, as submitted to the Congress in the January preceding the beginning of the fiscal year in July, is acted upon by the Congress in the same format that it is submitted: In appropriation or resource categories.

The fifth phase is conducted by the services after the defense budget is enacted into law. This phase requires another crosswalk to allocate the appropriations to programs and program elements, e.g., the Military Personnel, Navy (MPN)

appropriation must be broken down into MPN for strategic forces and MPN for general purpose forces (programs) and further into MPN allocations for submarines, destroyers, aircraft carriers, etc. This crosswalk shows how the service plans to apply the cuts made by the Congress in resource categories to the program elements. The crosswalk is done by the services; specific discussion of the documents and authorities involved in this crosswalk is contained in the Department of the Navy RDT&E Management Guide [5, p. 4-7].

The difference in the two crosswalks (the budgeting phase crosswalk and the allocation phase crosswalk) is considerable both in concept and practice. The budgeting phase crosswalk is aggregative. Since all programs and program elements list the requested appropriations, the crosswalk is executed by summing by appropriations across all programs and program elements. The allocation phase crosswalk is disaggregative. Since the Congressionally approved appropriations may be different from that which was requested, decisions must be made as to which programs and program elements are to receive cuts in their requested appropriations.

The chronological sequence of events in the defense budget process raises the question of whether or not decisions made in the first three phases (decisions which are coordinated by OSD) are consistent with decisions made by the Navy in the fifth phase. The next section will briefly discuss research done by Timothy W. Reufli [17] which indicates that it is likely that the services will alter plans made by OSD.

C. EFFECTS OF ORGANIZATION ON PPBS

According to Ruefli [17, p. 161], prior to 1971 most of the literature on PPBS was advocative in nature, dealing primarily with potential uses of the system in improving the decision making process. Ruefli departed from this approach and developed a complex goal programming model to describe and evaluate PPBS.

One of several conclusions Ruefli arrived at was that organization structure has significant effects upon the PPBS process, specifically upon the resulting resource allocations and defense force structure[3]. He arrived at this conclusion by applying his Generalized Goal Decomposition model to two different tri-level organization models. The first organization model consisted of OSD as the central unit (organization level one), mission oriented defense programs as the management units (organization level two), and program elements as the operating units (organization level three). The second organization model was the same with the exception of the service bureaucracies (Army, Navy, Air Force) replacing the defense programs as the management units. As noted earlier, the different organizations yielded different results, specifically in 10 of 12 different resource allocation and force level measurements that Ruefli analyzed for a sample problem.

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[3]Ruefli [17, p. 172] additionally stated that the lack of previous analytical models for studying PPBS may, "be regarded as a sympton...of the avoidance of organization considerations on the part of the advocates of PPBS," and also noted the complexity of injecting organization structure into economic decision making.

For this analysis, an analogy was constructed between the two organization models used by Ruefli and the DOD budget process described in Section II.B. Ruefli's first organization model with defense programs at the management level, corresponds to the organization structure used in the planning, programming and budgeting phases, phases one through three of the DOD budget process. The appropriation allocation process (phase five of the DOD budget process) conducted by the services to allocate the Congressionally approved appropriations to the programs and program elements is analogous to Ruefli's second organization model in which the services occupy the management level.

The implication of Ruefli's aforementioned conclusion applied to the DOD budget process through this analogy is that the plans and programs made prior to submission to the Congress may be changed not only by Congressional action but also by the allocation process conducted by the service after the Congress acts.

Using data on attack carriers this analysis attempts to test if this change occurs, as Ruefli concluded that it might, in DOD. Also, if the change appears to have occurred, the reasons or explanations for the change will be advanced.

III. METHODOLOGY FOR TESTING THE EFFECTS OF ORGANIZATION ON PPBS

The conclusion concerning the effects of organization on PPBS arrived at by Ruefli [17] was based primarily on the results of a hypothetical sample problem; however, it is the purpose of this paper to investigate the conclusion as it pertains to an actual DOD problem.

Based on the discussion of program budgeting in Section II.A. it is apparent that budgeting authorities possess at least an implicit production function. A more explicit description of the production function may be gained by observing that when a budgeting authority specifies x and y inputs to produce an output of z, he is explicitly specifying a point on the production surface $z = f(x,y)$. By estimating the program budget's and service budget's[4] production functions from a series of these explicitly specified production surface points, comparisons may be made between the two production functions to determine if the Navy and OSD perceive the same technology for the production of operating attack aircraft carriers.

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[4]Henceforth in the analysis, the term program budget will refer to the programs, program elements, force levels and resources determined during phases one through three of the PPB cycle. The term service budget will refer to the similar determination made by the service during phase five, the allocation phase.

A necessary condition for the service budget not to change the plans made under the program budget is the agreement of the service budget's production function for carriers with that of the program budget. In other words, if the Navy perceives a different technology for the production of carriers, or possibly a different output measure, from that which was used to formulate the program budget prior to Congressional consideration, then the plans made under the program budget structure would inevitably be changed during the allocation process.

A. SPECIFICATION OF PRODUCTION FUNCTIONS

1. Operational Definitions of Inputs and Outputs.

The inputs into the production process under consideration are numerous and difficult to measure in physical terms, however, they may be measured in dollar terms aggregated into appropriation categories as was done by Sovereign [19, p. 9]. Because procurement was not considered a pertinent input to the operation of carriers, only the appropriations Military Personnel, Navy (MPN) and Operations and Maintenance, Navy (OMN) were used.

The output measurement imposed a greater problem. The number of carriers operated was an obvious measure of output but was deceptive in so far as effectiveness was concerned. During the past decade the Essex/Hancock class carriers were replaced by the newer and larger Forrestal/Kitty

Hawk class and the Enterprise. While replacement was approximately on a 1:1 ratio, in some sense effectiveness increased, as did the operating costs, e.g., the capability of the Kitty Hawk class carriers to handle the A-6 aircraft gave them an all weather attack capability that the Hancock class lacked.

A second measurement problem for output is the dependence of effectiveness upon mission. Since carriers have a multi-mission capability, an effectiveness measure should probably take into account the mission and scenario[5].

For the purpose of this analysis, total operating tonnage was used as a compromise output measure. Tonnage was more representative of overall effectiveness than was total number of carriers, and was simple to derive. Had data been available on an activity level which the carrier force was expected to achieve such as the number of nautical miles steamed, a superior measure of output would have been ton-miles steamed, especially for modeling the Navy's allocation phase. As will be discussed in more detail in Section IV.C., based on the analysis, tonnage appears to be the measure of carrier output which OSD uses in the program budget; however, an activity level (such as nautical miles steamed or sorties launched) is in all likelihood an important consideration during the Navy's allocation phase.

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[5]Consider the differences in effectiveness of the Hancock and Kitty Hawk. If the mission is to "show the flag" in foreign ports, effectiveness of the two would be approximately equal. However, if the mission involved launching combat sorties, the Kitty Hawk would be more effective due to a larger air wing of more sophisticated aircraft.

2. Functional Forms.

Two alternative functional forms for the production function were considered to be of potential use in describing the data: The Cobb-Douglas and Leontief production functions. A primary difference in the two is the unrestricted substitution, from a strictly technological viewpoint, between inputs to produce a fixed output in the Cobb-Douglas and the fixed relationship or non-substitutability among inputs in the Leontief model.[6]

The two different functional forms were used because, as will be discussed in Section V., good arguments exist to justify the use of each of them. Rather than limit the results by depending on only one functional specification, the author elected to analyze the problem for both the Cobb-Douglas and Leontief functions.

a. Cobb-Douglas Production Function

The Cobb-Douglas production function is a commonly used functional form which has been used to describe many different production processes. For defense output, it has been used by Sovereign [19] to describe the operation of destroyers and by Lewis [15] to describe the output of Naval Air Stations.

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[6]Klein, L. R., Econometrics, p. 202, Row Peterson, 1956.

In terms of the variables in this analysis the function can be written as:

$$T = A(MPN)^{\alpha}(OMN)^{\beta}$$

where T is carrier tonnage,

MPN and OMN are appropriatons for carriers,

A is an efficiency parameter,

and α and β are elasticity parameters for MPN and OMN.

If constant returns to scale is desired, the following model may be used:

$$T = A(MPN)^{\alpha}(OMN)^{1-\alpha}$$

b. Leontief Production Function

The Leontief production function is another commonly used functional form of the production function, especially within the Department of Defense. It has been used in the Navy Resource Model (NARM), the Electric FYDP cost model, and by Sovereign [19] to describe the operation of destroyers.

In terms of the variables of this problem, the model takes the form:

$$T = \text{minimum } \left(\frac{MPN}{a}, \frac{OMN}{b}\right)$$

where T is carrier tonnage,

MPN and OMN are appropriations for carriers,

and a and b, are parameters.[7]

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[7] "a" and "b" may be interpreted as follows: for $\frac{MPN}{a} < \frac{OMN}{b}$, $\frac{1}{a}$ is the marginal product of MPN, and the marginal product of OMN is zero. For $\frac{MPN}{a} > \frac{OMN}{b}$, $\frac{1}{b}$ is the marginal product of OMN and the marginal product of MPN is zero.

B. DATA

The data on number and class of carriers and MPN and OMN in millions of dollars, unadjusted for inflation, for both the program budget and the service budget for the years 1964 through 1973 were obtained from the Department of the Navy Program Information Center. The data base was extracted from successive January updates of the Five Year Defense Plan (FYDP) computer outputs. The program budget data were extracted from the budget year column, e.g., from the January 1970 FYDP output, the 1971 program budget data were extracted from the column labeled FY71 and the 1970 service budget data were extracted from the column labeled FY70. The data extracted in this manner reflect (from the January 1970 output) the fiscal year 1971 budget after completion of phases one through three, and the fiscal year 1970 budget after completion of phase five[8].

The data were incomplete for one year in both budgets. For 1967 the program budget contains only Essex/Hancock and Midway class data. The same data deficiency occurs in the 1966 service budget. The incomplete data in no way affected the estimation procedures, since they were valid points on the production surface, and, except where otherwise noted, the analysis included the data for the incomplete years.

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[8]Congressional action on Defense Appropriations is usually not completed unitl October, over three months after the beginning of the fiscal year.

The number and class of carriers were converted to operating tonnage (in thousands) using the table in Appendix C, Aircraft Carrier Tonnage Conversion, which was derived from Jane's Fighting Ships [10, p. 433-445].

The appropriations were converted to constant 1969 dollars using Appendix D, Military Price Indices, which was derived from OSD (Comptroller) approved price indices in Ref. 6.

A complete listing of the data base is contained in Appendix E, Data Base (U), classified SECRET, which has been published as a separate document.

IV. DATA ANALYSIS

A. ESTIMATION OF PRODUCTION FUNCTION PARAMETERS

1. Estimation of the Cobb-Douglas Production Function.

The Cobb-Douglas function was estimated under the assumption of constant returns to scale. This is a reasonable assumption due to the consideration that both MPN and OMN for carriers do not contain any appreciable degree of fixed costs, and the consideration of the type of basic inputs in the appropriation categories. MPN contains resources such as pay and allowances for the assigned personnel, and OMN contains resources such as fuel, spare parts and funds for civilian personnel involved in maintenance and overhauls. The resources required in these categories should vary directly with the force size operated. Additionally, the elimination of one parameter increases the number of degrees of freedom by one, an especially desirable consequence when the number of data points is limited.

Due to the stochastic nature of the production process, an exponentially multiplicative error term was introduced into the model described in Section II.A.2.a. to represent the prediction errors. By making a logarithmic transformation, rearranging the terms and making the classical statistical assumptions for the stochastic disturbance, the parameters of the production function may be estimated by using ordinary least squares as suggested by Zellner, Kmenta, and Drèze [24].

$$T = A(MPN)^{\alpha}(OMN)^{1-\alpha}e^{\varepsilon}$$

$$\ell n(T) = \ell nA + \alpha\ \ell n(MPN) + (1-\alpha)\ell n(OMN) + \varepsilon$$

$$\ell n(T) - \ell n(OMN) = \ell nA + \alpha\ \ell n(MPN) - \alpha\ \ell n(OMN) + \varepsilon$$

$$\ell n\ (\frac{T}{OMN}) = \ell nA + \alpha\ \ell n\ (\frac{MPN}{OMN}) + \varepsilon$$

The following estimates resulted:

$$\ell n\ (\frac{\hat{T}}{OMN}) = 1.782 + \underset{(.092)}{0.854}\ \ell n\ (\frac{MPN}{OMN})$$

The standard error of this estimate was 0.054 and the coefficient of determination $R^2 = .915$. This regression resulted in the following estimated Cobb-Douglas function:

$$T = 5.942\ (MPN)^{0.854}(OMN)^{0.146}$$

The Cobb-Douglas function with constant returns to scale was similarly estimated for the data from the service budget with the following results:

$$\ell n\ (\frac{\hat{T}}{OMN}) = 1.611 + \underset{(.072)}{1.074}\ (\frac{MPN}{OMN})$$

and the following estimated equation:

$$T = 5.008\ (MPN)^{1.074}(OMN)^{-0.74}$$

While the standard error of the estimate is .042 and the coefficient of determination R^2 is .965, the elasticities are quite surprising. The negative elasticity -.074 implies that as OMN is increased, output decreases. An alternative explanation is that this elasticity is not statistically different from zero.[9]

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[9]To insure that the negative elasticities were not a result of the constant returns to scale assumption, the same data were used to estimate the Cobb-Douglas function without the restriction on scale. The resulting estimates of MPN and OMN elasticities were 1.114 and -0.042 with standard errors of 0.080 and 0.078. These were essentially the same results as with constant returns to scale, indicating that the scale restriction is not the cause of this somewhat unexpected result.

Because time series data were used to estimate these equations, it was desired to test against autocorrelation of the error terms. The Durbin-Watson statistic is perhaps the best known test for autocorrelation, however values of the test statistic are tabled only for values of $n \leq 15$. Since extrapolation of these statistics to $n = 10$ may have led to erroneous results, a less sophisticated method of examining the possibility of autoreggressive bias was selected. A sample coefficient of correlation was computed between the successive error terms in both regressions (program budget and service budget). The resulting coefficients were 0.14 (program budget) and -0.51 (service budget). The hypothesis that the error terms in both regressions are uncorrelated cannot be rejected at the .10 level of significance. Due to the results of this test, it was assumed that the analysis was not confounded by first order autoregressive bias.

Given the estimates for the parameters of the production functions under the program and service budgets, the Chow test described by Johnston [11, p. 136, 137] was performed to determine if a hypothesis that these parameters were the same could be rejected.

Under the null hypothesis that the service budget parameters are the same as the program budget parameters, the appropriate test statistic is an "F" statistic with 2 and 16 degrees of freedom in the numerator and denominator. The test statistic was calculated to be 5.77. The critical region at the .05 level of significance is $F \geq 3.63$, hence

the null hypothesis is rejected. The statistical interpretation of this test is that if the two production functions are the same, there is only a 5% chance that a test statistic this large or larger would be observed. Consequently there is statistical evidence to reject the null hypothesis and it is concluded that if the Cobb-Douglas function is the correct functional form for the program budget, then identical production functions are not being employed during phases one through three (program budget phase) and phase five (service budget allocation phase) of the defense budget process.

2. Estimation of the Leontief Production Function.

The Leontief model described in Section III.A.2.b. was estimated using the following model suggested by Klein [12, p. 134]:

$$\frac{MPN}{T} = a + \varepsilon_a \text{ and } \frac{OMN}{T} = b + \varepsilon_b$$

Under the assumption that the error terms ε_a and ε_b are normally distributed with zero means and respective variances σ_a^2 and σ_b^2, $\frac{MPN}{T}$ and $\frac{OMN}{T}$ are also distributed normally with means a and b and variances σ_a^2 and σ_b^2. The estimation procedure is simply to estimate the means a and b and the sample variances σ_a^2 and σ_b^2 using sample means and sample variances. The following estimates resulted from this procedure being applied to both program and service budget data:

	Program Budget	Service Budget
$\hat{a}$	.181	.194
$\hat{\sigma}_a^2$	.000121	.000100
$\hat{b}$	.111	.129
$\hat{\sigma}_b^2$	.000361	.001156

A statistical test was conducted to determine if the parameters of the production function for the program budget data were the same as those for the service budget data. The null hypotheses tested were that $a_{PB} = a_{SB}$ and $b_{PB} = b_{SB}$, where the subscripts PB and SB denote the parameters of the program budget and service budget production functions.

Testing for equality between means of two normal populations in the presence of unknown and unequal variances constitutes an unsolved statistical problem known as the Behrens-Fischer problem. However, Welch [22] states that the following statistic with an approximate "t" distribution may be used as an approximation to test the hypothesis:

$$t_a = \frac{(\hat{a}_{PB} - \hat{a}_{SB})}{\sqrt{\dfrac{\hat{\sigma}^2_{a\,'PB}}{N_{PB}} + \dfrac{\hat{\sigma}^2_{a\,'PB}}{N_{SB}}}}$$

where N_{PB} and N_{SB} represent the number of sample points in each population. An identical test statistic with b replacing a in the subscripts and estimates is applicable to testing the hypothesis that $b_{PB} = b_{SB}$. Under the null hypothesis, the test statistic is distributed approximately "t" with the following approximate degrees of freedom:

$$df = \frac{[\hat{\sigma}_a^2{}_{,PB}/N_{PB} + \hat{\sigma}_a^2{}_{,SB}/N_{SB}]^2}{\frac{(\hat{\sigma}_a^2{}_{,PB}/N_{PB})^2}{N_{PB}} + \frac{(\hat{\sigma}_a^2{}_{,SB}/N_{SB})}{N_{SB}}}$$

The following test statistics and approximate degrees of freedom were computed for both null hypotheses with the degrees of freedom rounded to the nearest integer:

H_o: $a_{BP} = a_{SB}$

$t_a = 2.766$ $\qquad$ $df = 20$

H_o: $b_{PB} = b_{SB}$

$t_b = 1.460$ $\qquad$ $df = 16$

For the first hypothesis with 20 degrees of freedom and a significance level of .02[10], the critical values of the "t" distribution are $\pm$ 2.528. Since $t = 2.766 > 2.528$ the hypothesis that $a_{PB} = a_{SB}$ is rejected.

For the second hypothesis with 16 degrees of freedom and the same significance level, the critical values are +2.583. However, since $-2.583 < t_b < 2.583$, the hypothesis that $b_{PB} = b_{SB}$ cannot be rejected.

While the two individual hypotheses that $a_{PB} = a_{SB}$ and $b_{PB} = b_{SB}$ have both been tested, it still remains to test the single hypothesis that the production function of the program budget is the same as that of the service budget. This is equivalent to testing that both $a_{PB} = a_{SB}$ <u>and</u> $b_{PB} = b_{SB}$. If the estimates for a_{PB} and b_{PB} were independent and the estimates for a_{SB} and b_{SB} were independent, it would

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[10]These hypotheses were tested at the .02 level of significance to provide the basic results from which to test a broader hypothesis that both $a_{PB} = a_{SB}$ <u>and</u> $b_{PB} = b_{SB}$ further on in this section.

be a simple matter of invoking the properties of independent random variables. However, these estimates,are not independent because each used the same measure of output, i.e., the estimates for a_{PB} used $\frac{MPN_{PB}}{T_{PB}}$ and the estimate for b_{PB} used $\frac{OMN_{PB}}{T_{PB}}$, each with a common factor of T_{PB}.

A rejection region for the single hypothesis may be constructed by using the following argument presented by Theil [20, p. 132], on the similar subject of simultaneous confidence regions. Under the two null hypotheses that $a_{PB} = a_{SB}$ and that $b_{PB} = b_{SB}$,

$$Pr(t_a \varepsilon A_a) = 1 - \alpha_a \text{ and } Pr(t_b \varepsilon A_b) = 1 - \alpha_b$$

where A_a and A_b are the acceptance regions (more formally the non-rejection regions) and α_a and α_b are the significance levels, .02 in this case, for each test. Under the null hypotheses that $a_{PB} = a_{SB}$ <u>and</u> $b_{PB} = b_{SB}$, the appropriate probability of non-rejection is:

$$\begin{aligned}
Pr(t_a \varepsilon A_a, t_b \varepsilon A_b) &= 1 - Pr(t_a \not\varepsilon A_a, t_b \varepsilon A_b) - Pr(t_a \varepsilon A_a, t_b \not\varepsilon A_b) \\
&\quad - Pr(t_a \not\varepsilon A_a, t_b \not\varepsilon A_b) \\
&\geq 1 - \{Pr(t_a \not\varepsilon A_a, t_b \varepsilon A_b) + Pr(t_a \not\varepsilon A_a, t_b \not\varepsilon A_b)\} \\
&\quad - \{Pr(t_a \varepsilon A_a, t_b \not\varepsilon A_b) + Pr(t_a \not\varepsilon A_a, t_b \not\varepsilon A_b)\} \\
&= 1 - Pr(t_a \not\varepsilon A_a) - Pr(t_b \not\varepsilon A_b) \\
&= 1 - \alpha_a - \alpha_b = 1 - .02 - .02 = .96 > .95
\end{aligned}$$

This probabilistic argument indicates that under the null hypothesis that the production functions are equivalent, i.e., that $a_{PB} = a_{SB}$ and $b_{PB} = b_{SB}$, the probability of both t statistics, t_a and t_b, falling in their respective acceptance regions is greater than .95; or conversely the probability of one or both test statistics falling outside the region is less than .05. Since the null hypothesis that $a_{PB} = a_{SB}$ was rejected at the .02 level of significance, the broader hypothesis that the production functions are the same is rejected at the .05 level of significance the same level used in the Cobb-Douglas case.

In the previous section, it was determined that if a Cobb-Douglas production function was the appropriate production function for describing resource allocations to carriers, then plans made in phases one through three of the budget process were being altered in phase five. The analysis of this section has arrived at the same conclusion if the Leontief production function is the correct functional form.

B. AN EXAMINATION OF BUDGET ADJUSTMENTS IN THE CARRIER PROGRAM ELEMENT

In Section III.A., under the assumption that a Cobb-Douglas production function with constant returns to scale described the data, the estimated elasticities for MPN and OMN were 0.854 and 0.146 respectively. The elasticity for a particular input is the percentage change in output which

would result from a given percentage change in that input alone. In interpreting the program budget, the elasticities yield some insight into the relative importance that OSD places on these inputs. In this case it appears that OSD views MPN as considerably more important than OMN for the carrier program elements.

Given service freedom in allocating budget cuts, it would appear that if the Navy's point of view at all corresponds to the OSD point of view, then the service would want to concentrate an appropriation or resource cut in a program element with low elasticity (such as the carrier program element with an OMN elasticity of 0.146) and place emphasis on maintaining or increasing the level of a resource in a program element with a high elasticity.

In the light of these considerations an attempt was made to investigate if there was any consistent linear relationship between the cuts made in the defense budget by the Congress and the cuts allocated to carriers by the Navy.

The two years 1966 and 1967 were disregarded due to deficiencies in the data noted in Section III.B. Additionally, the data for 1971, 1972 and 1973 were also disregarded because in those years the output measure for tonnage was changed in the service budget from that which appeared in the program budget, and the effects of this change in output could not be removed from the data without introducing estimation errors. Remaining were five years, 1964-1965 and 1968-1970.

For these five years, the percentage changes in the defense budget imposed by the Congress in the MPN and OMN appropriations were computed using successive editions of the Appendix to the Budget of the United States [1]. These percentage changes (Congressional changes) were then compared to the Navy's allocation of the cuts to the carrier program element. The percentage changes in the MPN and OMN allocation for the carrier program element, from the program budget (from which the budget request was prepared for submission to Congress) to the service budget, were also computed. This data appears in Appendix F, Appropriation Percentage Changes.

Sample coefficients of correlation were computed between the Congressional percentage changes in MPN and OMN in the overall Navy budget and the service percentage changes for both MPN and OMN in the carrier program element. The computed coefficients were -.33 for MPN and +.34 for OMN.

If the cuts imposed by both the Congress and the service are normally distributed random variables,[11] a test on the null hypothesis that the coefficient is equal to zero may be performed as described by Dixon and Massey [4, p. 204]. The critical values tabled by Dixon and Massey [4 p. 569] call for rejection of the null hypothesis if the sample coefficient is outside the range (-.81, +.81) at the .10 level of significance. In fact, at the .50 level of significance (a 50-50 chance of

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[11]This is an extension of the assumption made by Crecine and Fischer [2] that budget cuts are made by "rules of thumb" which are statistically predictable.

rejecting the null hypothesis when it is true) the hypothesis cannot be rejected (critical values of $\pm.40$). Examination of the data may be more revealing than the above computations.

When the data below, with the addition of the years 1971 and 1972, are closely examined, two observations appear to be relevant.

YEAR	CVA MPN[12]	TOT MPN[13]	CVA OMN[12]	TOT OMN[13]
1964	-4.2	-2.3	+2.7	-0.7
1965	-0.1	-0.3	-8.3	-0.5
1968	+7.2	-0.9	+31.6	-1.1
1969	+5.0	-2.4	-7.6	-6.1
1970	+9.6	-3.5	+0.4	-6.4
1971[14]	+4.5	-0.8	+4.7	-1.6
1972[14]	+11.9	+4.8	+8.5	+0.9

---

[12]CVA MPN and CVA OMN represent the percentage changes made by the Navy in the program budget's MPN and OMN allocations to carriers to arrive at the service budget.

[13]TOT MPN and TOT OMN represent the percentage changes made by the Congress in the requested defense budget.

[14]The operating tonnage for years 1971 and 1972 was changed in the service budget by -4.7% and +4.8% respectively. The year 1973 was omitted due to a large decrease in the output tonnage.

The first observation is the exceedingly large increase in OMN allocated by the Navy to carriers in 1968 in the face of a small overall decrease in OMN by the Congress. It should be noted that fiscal year 1968 (corresponding to the calendar period July 1967 through June 1968) was a year of heavy United States involvement in Southeast Asia in which carriers played a major role.

The second observation is the trend toward increased allocation to carriers of both OMN and MPN since 1968 in the face of general cuts by the Congress.

These observations tend to support an argument that the FYDP (which is cast in terms of physical force units) does not consider proposed activity levels while the Navy's allocation process does, i.e., the Navy is allocating resources to a different output from that being considered by OSD. This may have caused the estimation of the negative elasticity in the Cobb-Douglas function when it was applied to the service budget data in that the service budget production function was probably specified incorrectly. At phase five of the budget process, the Navy has a relatively clear idea of what its operating requirements for carriers are going to be in the next ten to twelve months. Consequently, it is most likely allocating resources to the carrier program element for an output like ton-miles steamed rather than total tonnage which OSD maintains in FYDP program element

summary data files and apparently budgets for. Put another way, OMN and MPN are allocated for the production of carrier tonnage during phases one through three (the program budget phase) and for the production of a different output such as ton-miles steamed during phase five.

Another possibility which the data support is that the Navy values the defense output of carriers more than does OSD.

Either or both of these arguments are consistent with the conclusion arrived at by Ruefli [17, p. 203, 204] that different organization structures will not only lead to different resource allocations, but will also lead to different activities or outputs of the operating units.

Ruefli [17, p. 204] goes on to state that some type of control mechanism (crossover network) is required to insure that, in the terms of this paper, the service allocation in phase five of the budget cycle is consistent with the plans made in phases one through three with regard to both resource allocation and program element activity level.

V. INTERPRETATION OF RESULTS

A. SUMMARY OF ANALYTICAL RESULTS

Under the assumption that either a Cobb-Douglas or Leontief production function describes the budgeting for the operation of carriers, the hypothesis that the program and service budgets are the same can be statistically rejected at a high (.05) level of significance. Also, an examination of percentage cuts likewise fails to indicate that service behavior, after Congressional action, is consistent with the plans made under the program budget. Of course, the tests conducted were dependent upon making the correct functional specification of the production function. In this case it seems reasonable to assume that one of the models does in fact correctly specify the production process. The Cobb-Douglas function has been widely used to describe many different production processes,[15] and the linear Leontief model is used extensively in DOD planning.

This paper set out to determine if the Navy's resource allocation to carriers in the service budget was consistent with the resource allocation arrived at by OSD in the program budget. The analysis was able to conclude that the two resource

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[15] Klein [12, p. 91] noted that C. W. Cobb and P. H. Douglas have proposed their model, "as a fairly universal law of production..."

allocations were not the same. Additionally there is evidence though less conclusive, that the Navy budgets for a higher carrier activity level than does OSD.

It would be hasty to conclude that these results confirm the conclusion arrived at by Ruefli [17] that the cause of the difference is the DOD organization structure. As stated in Section III, "A necessary condition for the service budget not to change the plans made under the program budget is the agreement of the service budget's production function for carriers with that of the program budget." It follows that the results of the analysis indicate that the allocation process which defines the service budget has changed the plans made in the program budget. While differences in organization structure is the vehicle that permitted these plans to be changed, factors other than organization may have influenced the changes or necessitated them.

B. EXPLANATION OF RESULTS OTHER THAN ORGANIZATION STRUCTURE

The years covered by the data (1964-1973) were a period of considerable turmoil in national security due to the Southeast Asian situation in which carriers played a large role. With regard to budgeting during this period, it should be kept in mind that there was a time lag of roughly a full year between the formulation of the program and service budgets. The oft-repeated phrase "light at the end of the tunnel" may have had the effect of influencing the program

budget to underestimate the resources which were actually required for the following fiscal year.[16] At the time the service budget was formulated, approximately a full year after the program budget was formulated, it may have been necessary for the service to inject additional resources into the program element to meet operational requirements because the "end of the tunnel" had not yet materialized. This points up what is essentially uncertainty in the PPBS, moreover uncertainty would be present in any long range planning system used by DOD. Even the allocation phase includes provisions for uncertainty through the use of reprogramming which permits resources to be shifted between programs and program elements during the fiscal year as the necessity becomes evident.

A second possible reason for disagreement between the two budgets is a tentative hypothesis of downward inelasticity of defense force levels. Consider a hypothetical situation in which DOD proposes to operate 10 force units using x and y inputs. If the inputs (appropriations) are each cut by 10%, a decision may be made to operate all 10 force units using only 90% of the proposed inputs (each force unit operating at 90% of its full effectiveness) rather than 9 force units, each operated at 100% effectiveness. A behavioral assumption based on this reasoning is realistic if DOD is considered to have a secondary objective of maintaining a base for

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[16]This behavioral trait was attributed to former Secretary of Defense Robert McNamara by Korb [14].

mobilization. As applied to aircraft carriers, the expected cost of putting one ship into mothballs and then reactivating it a year later would be quite high, not to mention the cost of not having it available if it was urgently needed, if the uncertainty of its requirement in near future years was high.

Both of these factors stated would have been susceptible to analysis if an improved and consistent measure of output or effectiveness were available. With regard to the uncertainty of and the time lag between the formulation of the budgets, if an activity level for which each budget was formulated had been known (such as operating days at sea or nautical miles steamed) then the output measure would have better reflected the true capability budgeted for, if OSD or the service were in fact budgeting for that output. With regard to maintaining a mobilization base, a similar benefit would have accrued knowing that the 10 hypothetical force units were being operated at only 90% of full effectiveness.

With regard to consistency of the output measure, there is some evidence that OSD and the Navy may in fact be using different output measures, i.e., OSD appears to be using tonnage as the output measure while the Navy resource allocation phase very well may be using either explictly or implicitly a tonnage activity level. This is as much a problem in the application of PPBS as it is an organization problem. With regard to this problem Hitch [8, p. 32] is requoted: "Wherever possible, program elements are measured in physical terms such as numbers of aircraft per wing, numbers of

operational missiles..." This measure may not be completely satisfactory for program elements (particularly general purpose forces) subject to rapid acceleration and deceleration in operations due to changing world situations. It also does not consider the operational commitments of a program element. As an example, it does not consider the difference in 13 carriers with operational commitments for an average of six months deployed as opposed to the same 13 carriers with operational commitments for an average of seven months deployed, with regard to inputs or output.

These observations appear to be particularly relevant to the low coefficients of correlation computed in Section IV.B., e.g. from Appendix F, the large increase in OMN allocated for carriers in 1968, a year of high carrier activity in Southeast Asia, in the presence of a slight cut imposed in overall OMN by the Congress.

The aforementioned discussion notwithstanding, the analysis is considered as supportive of Ruefli's conclusion that under the present organization of the Department of Defense, the plans made on a program basis can and in fact have been changed by the resource allocation process, even though these changes may not be organizationally grounded.

C. RECOMMENDATIONS FOR FURTHER RESEARCH

Two areas appear to hold particular promise for further research effort. The first is the area of analysis similar to this but on different program elements. As noted earlier both the program and service budgets may be sensitive to international events, and during the period from which data was extracted, carrier budgets (particularly the service budget) may have been significantly influenced by the ever changing situation in Southeast Asia. A similar analysis conducted on a program element from Major Program I, Strategic Forces, such as Fleet Ballistic Missile Submarines may yield considerable insight into how sensitive the budget is with regard to international political/military instability.

A second fertile area for study involves an improved output measure. This analysis utilized what was considered to be the best of those available measures of output. It is felt that some of the analysis and conclusions would be more powerful had a more definitive output measure, especially for the service budget phase, been available. In devising improved output measures, attention should be directed to some measure of the activity level being budgeted for. Additional investigation might also be made into what output measurements are actually being used. While it is apparent from both this analysis and the literature that the preparation of the program budget uses force levels as an output measure, it would be advantageous to determine if the Navy, in phase five

of the budget process, uses either explicitly or implicitly an activity level in conjunction with force level and what that activity level might be.

A final suggested area of research involves examining simultaneously substitutive program elements within a single major program. This would provide a basis for conducting a trade-off analysis of appropriation cuts between program elements.

D. SUMMARY

This analysis was an investigation of the consistency or inconsistency of resource allocation decisions on attack carriers by the Office of the Secretary of Defense and the Navy at different times in the budget cycle. Section II. discussed the background for the study. First, the theory of program budgeting was presented as a foundation for the use of production function analysis to investigate the consistency of these decisions. A discussion of the defense budget cycle was presented to specify those points in the cycle that the decisions were to be analyzed. Previous research work by Ruefli [17] was also discussed to provide a basis and motivation for this paper, specifically Ruefli's conclusion that different decisions might be made at different points in the budget cycle.

Section III. specified two different functional forms of the production function, the Cobb-Douglas and Leontief

and defined the inputs and output used in the analysis. Section III. also contained a discussion of how the data representing OSD and Navy decisions were extracted from successive outputs of the Five Year Defense Plan.

Section IV. presented the results of the statistical estimation of the parameters of the different production functions and hypothesis testing for consistency of the OSD and Navy resource allocation decisions. Under both functional specifications, the hypothesis was rejected that OSD and Navy decisions were consistent. A correlation analysis was also performed which showed that the Navy and Congressional percentage changes in inputs for carriers were not related. Finally, a subjective examination of these percentage changes indicated that the Navy may have used a different output measure, either explicitly or implicitly, from that which the OSD decisions were based upon.

This final section, Section V., concluded that the decisions made by the Navy in the allocation phase of the budget cycle were inconsistent with the decisions made by OSD in the planning, programming and budgeting phases. Underlying causes for the inconsistencies were suggested as being the result of inconsistencies in the output measures used by OSD and the Navy, the time lag between the decisions during periods of international political/military instability, and the possibly downward inelasticity of defense force levels.

APPENDIX A Defense Programs and Appropriations

I. Major programs:

0(Zero)	-	Support of Other Nations
I	-	Strategic Forces
II	-	General Purpose Forces
III	-	Intelligence and Communications
IV	-	Airlift and Sealift
V	-	Guard and Reserve Affairs
VI	-	Research and Development
VII	-	Central Supply and Maintenance
VIII	-	Training, Medical and Other Personnel Activities
IX	-	Administration and Associated Activities

II. Navy Appropriations:

Research, Development, Test and Evaluation, Navy	RDTEN
Procurement Aircraft and Missiles, Navy	PAMN
Shipbuilding and Conversion, Navy	SCN
Other Procurement, Navy	OPN
Military Construction, Navy	MCON
Military Personnel, Navy	MPN
Reserve Personnel, Navy	RPN
Operations and Maintenance, Navy	OMN

APPENDIX B Program Element Summary Data

PE 2 41 22 N F-20 Squadrons	FY 72	FY 73	FY 74	FY 75	FY 76	FY 77	FY 78
Forces F-20			11	44	150	250	300
R&D							
RDT&EN	50,000	30,700	15,072				
INVESTMENT							
PAMN		413,500	381,040	217,690	308,100		
OPN			717	4,113	8,050		
TOTAL INVESTMENT		413,500	381,757	221,803	316,150		
OPERATING							
MPN			872	4,290	14,005		
OMN			6,326	14,079	44,010		
TOTAL OPERATING			7,198	18,369	58,015		
TOTAL TOA	50,000	444,200	404,027	240,172	374,165		
MANPOWER							
MILITARY			169	1,248	4,044		

APPENDIX C Aircraft Carrier Tonnage Conversion

Class	Tonnage (in thousands)
Kennedy	87.0
Forrestal	78.0
Kitty Hawk	80.0
Midway	64.0
Enterprise	89.6
Essex/Hancock	44.7

APPENDIX D Military Price Indices

Fiscal Year	MPN	OMN
1964	.767	.826
1965	.802	.865
1966	.866	.895
1967	.892	.926
1968	.934	.955
1969	1.000	1.000
1970	1.131	1.078
1971	1.217	1.146
1972	1.405	1.203
1973	1.582	1.250

APPENDIX F Appropriation Percentage Changes

Year	CVA MPN	TOT MPN
1964	-4.2	-2.3
1965	-0.1	-0.3
1968	+7.2	-0.9
1969	+5.0	-2.4
1970	+9.6	-3.5

Year	CVA OMN	TOT OMN
1964	+2.7	-0.7
1965	-8.3	-0.5
1968	+31.6	-1.1
1969	-7.6	-6.1
1970	+0.4	-6.4

APPENDIX G Omitted Variables

Suppose that the output from the production process was not a single entity but in fact was a combination of various components. The production function would then relate the various inputs to the combination of output elements.

One possible multi-output specification would be:

$$(1) \quad W_1Q_1 \cdot W_2Q_2 = A\, x_1^{\alpha} x_2^{\beta} e^{u}$$

where the Q's are output components, the W's weights, the x's are inputs, and α and β are elasticities.

If this were the correct specification, the parameters would be estimated by the following:

$$(2) \quad \ell nQ_1 = [\ell nA - \ell nQ_2 - \ell nW_2 - \ell nW_1] + \alpha \ell nx_1 + \beta \ell nx_2 + u$$

In this case the omission of Q_2 or any other component of the output would tend to bias the intercept term. The estimated value would be larger than appropriate.

If the measure of output were of the following form:

$$(3) \quad Q_1^{W_1} \cdot Q_2^{W_2} = Ax_1^{\alpha} x_2^{\beta} e^{u} ,$$

the omission of Q_2 would be more complicated. To estimate the parameters, the following transformed function would be used:

$$(4) \quad \ell nQ_1 = [\frac{1}{W_1} \ell nA] + \frac{\alpha}{W_1} \ell nx_1 + \frac{\beta}{W_1} \ell nx_2 + \frac{W_2}{W_1} \ell nQ_2 + u^*$$

As in the previous case, the intercept is influenced by the unknown weight parameter. In addition the coefficients of the input terms are biased. The coefficients are not the output elasticities but are in fact less than the output elasticities, since the weights are positive. Also, the omission of Q_2 would have an influence on the estimation of $\frac{\alpha}{W_1}$ and $\frac{\beta}{W_2}$. The omission of the relevant explanatory Q_2 would, in general, cause the values of the coefficients of x_1 and x_2 to be biased upward. For a more complete analysis of the omission of relevant explanatory variables, see Elements of Econometrics by Jan Kmenta, published by MacMillan Company, pages 392 through 395.

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This analysis establishes and tests conditions for consistency of the post-appropriation resource allocation to attack aircraft carriers by the Navy and plans made by the Office of the Secretary of Defense under the Planning Programming Budgeting System. The Cobb-Douglas and Leontief production

functions, using carrier operating tonnage as an output measure and Military Personnel and Operations and Maintenance appropriation dollars as inputs, are considered as possible models to explain the implicit economic technology used during different phases of the budgeting process. Econometric techniques, correlation analysis and other methods are used in analyzing data covering 1964 through 1973. A conclusion is reached that the Navy post-appropriation resource allocation did in fact alter plans made by OSD; both Department of Defense organization and other factors are discussed as potential explanations for the observed results.

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C704 Connell
c.1 The effects of Department of Defense organization on attack aircraft carrier budgeting.